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Docket No.: IRDM.031CPCP/IDC-0006B1B1 **CUSTOMER NO. 20995**

Applicant	:	MILES et al.
U.S. Patent No.	:	6,710,908 (U.S. Appln. No. 10/076,224)
Issue Date	:	March 23, 2004
For	:	CONTROLLING MICRO-ELECTRO-MECHANICAL CAVITIES

CERTIFICATE OF FAX TRANSMISSION

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Mark M. Abumeri, Reg. No. 43,458

Transmitted herewith for filing and consideration in the above-referenced application are the following documents:

(X) Letter to the Commissioner of Patents enclosing Certificate of Correction in 1 page.
(X) Certificate of Correction in 1 page.
(X) Pertinent Pages of the issued patent (2 pages).
(X) Total pages in transmission: 5

Certificate
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The Commissioner is hereby authorized to charge any additional fees which may be required, now or in the future, or credit any overpayment to Account No. 11-1410.

Mark M. Abumeri
Registration No. 43,458
Attorney of Record
Customer No. 20,995
(619) 235-8550

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Knobbe Martens Olson & Bear LLP
Intellectual Property Law

550 West C Street
Suite 1200
San Diego CA 92101
Tel 619-235-8550
Fax 619-235-0176
www.kmob.com

March 7, 2008

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: Title: CONTROLLING MICRO-ELECTRO-MECHANICAL CAVITIES
Letters Patent No. 6,710,908
Application No. 10/076,224
Issued: March 23, 2004
Our Reference: IRDM.031CPCP

Dear Sir:

Enclosed for filing is a Certificate of Correction in connection with the above-identified patent. This Certificate of Correction seeks to have the priority claim found on the front page of the above-issued patent at field (63) changed to match the correct claim of priority found in the Specification. The Specification of the above-issued patent at Column 1, Lines 3-16 correctly states the sequence of priority. A copy of the pertinent page of the above-issued patent is attached for your reference.

In contrast, the front page of the above-identified patent at field (63), entitled "Related U.S. Application Data," does not reflect the correct priority claim as found in the Specification of the above-issued patent. Since it appears that the error cited in this Certificate of Correction was incurred through the fault of the Patent Office, no fee is believed to be required. However, please charge our Deposit Account No. 11-1410 for any fees that may be incurred with this request.

Respectfully submitted,

Knobbe, Martens, Olson & Bear, LLP

Mark M. Abumeri
Registration No. 43,458
Customer No. 20,995

Enclosures

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UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,710,908
APPLICATION NO. : 10/076,224
ISSUE DATE : March 23, 2004
INVENTOR(S) : Miles et al.

It is certified that errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the front page of the patent after field (63), please delete the following:

"Continuation-in-part of application No. 09/974,544, filed on Oct. 10, 2001, and a continuation-in-part of application No. 09/378,143, filed on Aug. 20, 1999, now abandoned, and a continuation-in-part of application No. 09/056,975, filed on Apr. 8, 1998, which is a division of application No. 08/769,947, filed on Dec. 19, 1996, now abandoned, which is a continuation of application No. 08/744,253, filed on Nov. 5, 1996, now Pat. No. 5,986,796, which is a continuation-in-part of application No. 08/554,630, filed on Nov. 6, 1995, now abandoned, which is a continuation-in-part of application No. 08/238,750, filed on May 5, 1994, now Pat. No. 5,835,255."

And insert the following on the front page of the patent after field (63):

--Continuation-in-part of U.S. patent application serial number 09/378,143, filed August 20, 1999, which is a continuation of U.S. patent application Serial No. 08/744,253, filed November 5, 1996, now issued as U.S. Patent No. 5,986,796; a continuation-in-part of U.S. patent application Serial No. 09/056,975, filed April 8, 1998; and a continuation-in-part of U.S. patent application Serial No. 09/974,544, filed October 10, 2001, which is a divisional of U.S. patent application Serial No. 08/769,947, filed December 19, 1996, now abandoned, which is a continuation-in-part of U.S. patent application Serial No. 08/554,630, filed November 6, 1995, now abandoned, which is a continuation-in-part of U.S. patent application Serial No. 08/238,750, filed May 5, 1994, now issued as U.S. Patent No. 5,835,255, all incorporated here by reference.--

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MAILING ADDRESS OF SENDER:

Mark M. Abumeri
KNOBBE, MARTENS, OLSON & BEAR, LLP
2040 Main Street, 14th Floor
Irvine, California 92614

DOCKET NO. IRDM.031CPCP

US006710908B2

(12) **United States Patent**
Miles et al.

(10) **Patent No.: US 6,710,908 B2**
(45) **Date of Patent: Mar. 23, 2004**

(54) **CONTROLLING MICRO-ELECTRO-MECHANICAL CAVITIES**

(75) Inventors: **Mark W. Miles**, San Francisco, CA (US); **Clarence Chui**, Emeryville, CA (US)

(73) Assignee: **Iridigm Display Corporation**, San Francisco, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/076,224**

(22) Filed: **Feb. 13, 2002**

(65) **Prior Publication Data**

US 2002/0149828 A1 Oct. 17, 2002

Related U.S. Application Data

(63) Continuation-in-part of application No. 09/974,544, filed on Oct. 10, 2001, and a continuation-in-part of application No. 09/378,143, filed on Aug. 20, 1999, now abandoned, and a continuation-in-part of application No. 09/056,975, filed on Apr. 8, 1998, which is a division of application No. 08/769,947, filed on Dec. 19, 1996, now abandoned, which is a continuation of application No. 08/744,253, filed on Nov. 5, 1996, now Pat. No. 5,986,796, which is a continuation-in-part of application No. 08/554,630, filed on Nov. 6, 1995, now abandoned, which is a continuation-in-part of application No. 08/238,750, filed on May 5, 1994, now Pat. No. 5,835,255.

(51) **Int. Cl.**[7] **G02B 26/00**

(52) **U.S. Cl.** **359/290**; 359/291; 359/292; 372/20; 372/32

(58) **Field of Search** 359/245, 247, 359/2, 52, 254, 25, 5, 290–292, 577, 578; 356/519, 454, 345; 372/20, 32; 385/14, 16, 24; 345/85

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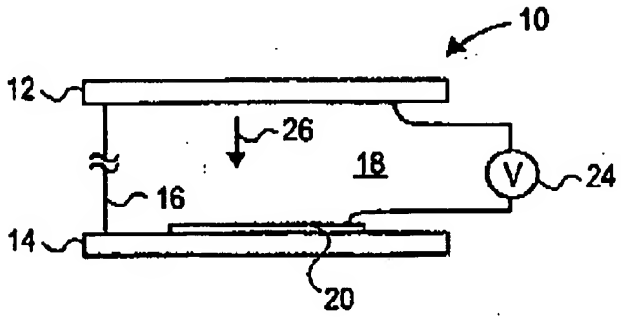
Primary Examiner—Georgia Epps
Assistant Examiner—M. Hasan
(74) *Attorney, Agent, or Firm*—Blakely, Sokoloff, Taylor & Zafman, LLP

(57) **ABSTRACT**

Among other things, a cavity having a cavity dimension is configured so that the cavity dimension changes in response to electrostatic forces applied to the cavity, and at least two electrical structures are configured to apply electrostatic forces in the vicinity of the cavity, the electrical structures being independently controllable.

29 Claims, 8 Drawing Sheets



CONTROLLING MICRO-ELECTRO-MECHANICAL CAVITIES

This application is continuation-in-part of U.S. patent application Ser. No. 09/378,143, filed Aug. 20, 1999, now abandoned, which is a continuation of U.S. patent application Ser. No. 08/744,253 filed Nov. 5, 1996, now issued as U.S. Pat. No. 5,986,796: a continuation-in-part of U.S. patent application Ser. No. 09/056,975, filled Apr. 8, 1998; and a continuation-in-part of U.S. patent application Ser. No. 09/974,544, filled Oct. 10, 2001, which is a divisional of U.S. patent application Ser. No. 08/769,947, filed Dec. 19, 1996, now abandoned, which is a continuation-in-part of U.S. patent application Ser. No. 08/554,630 filed Nov. 6, 1995, now abandoned, which is a continuation-in-part of U.S. patent application Ser. No. 08/238,750, filed May 5, 1994, now issued as U.S. Pat. No. 5,835,255, all incorporated here by reference.

BACKGROUND

This invention relates to controlling micro-electro-mechanical cavities.

As shown in FIG. 1, a micro-electro-mechanical structure (MEMS) **10** can be formed to have two walls **12**, **14** connected mechanically **16** to define a cavity **18**. The walls of the cavity can be movable relative to one another to control, for example, interferometric optical properties of the cavity. An electrode **20** can be formed on one of the walls so that, when a sufficient voltage V_A (see FIG. 2) from a voltage source **24** is applied between the electrode and the opposite wall **12**, the activation threshold of the cavity is exceeded and the wall **12** is drawn close to the wall **14** by electrostatic force **26**. Because of a hysteresis effect, the wall **12** will then remain close to wall **14** even if the voltage falls below V_A. Only when the voltage falls below a lower value, V_B, will the wall **12** return to its original position.

SUMMARY

In general, in one aspect, the invention features apparatus that includes a cavity having a cavity dimension, the cavity being configured so that the cavity dimension changes in response to electrostatic forces applied to the cavity, and at least two electrical structures configured to apply electrostatic forces in the vicinity of the cavity, the electrical structures being independently controllable.

Implementations of the invention may include the following features. The cavity dimension is determined by a distance between two walls, and the cavity dimension determines optical properties of the cavity. The optical properties include interference or reflectance. The two electrical structures comprise electrodes. The electrical structures lie on a wall of the cavity. The electrical structures lie side by side on the wall of the cavity. The cavity comprises an interference modulator and the cavity dimension determines an optical state of the modulator. Changes in the cavity dimension that occur in response to the electrostatics forces are characterized by hysteresis. There is also a second cavity adjacent to the cavity. The cavity and the second cavity share a common wall.

There are also stops within the cavity, the stops defining an intermediate cavity dimension between a minimum cavity dimension and a maximum cavity dimension the stops define channels between them portions of a wall of the cavity lie in response to electrostatic forces. One of the electrical structures comprises electrodes embedded within the stops. The stops lie on a movable wall of the cavity. Apertures in a second wall of the cavity are configured to receive the stops. There are also additional cavities having cavity dimensions, each of the cavities being configured so that its cavity dimension changes in response to electrostatic forces applied to the cavity. There are additional electrical structures configured to apply electrostatic forces in the vicinities of the cavities, each of the additional cavities being associated with at least two of the additional electrical structures. The electrical structures with which each of the cavities is associated are independently controllable. At least some of the electrical structures associated with at least some of the respective cavities are coupled together.

The cavities are organized in groups by coupling together of selected electrical structures. The coupling comprises bus conductors. The coupling comprises bus elements fabricated on multiple levels of the apparatus.

In general, in another aspect, the invention features apparatus that includes an array of interferometric modulators, actuation electrodes associated with the respective interferometric modulators, and a pattern of conductors connecting the actuation electrodes in groups.

Implementations of the invention may include the following features. The groups comprise rows or columns of the actuation electrodes. The groups comprise pixels of a display. Each of the interferometric modulators is associated with more than one of the electrodes. The pattern of conductors connects different ones of the electrodes associated with each of the interferometric modulators in a configuration that enables them to be energized independently. The electrodes are arranged on walls of cavities of the interferometric modulators.

In general, in another aspect, the invention features a method that includes energizing one electrical structure to apply an electrostatic force in the vicinity of a cavity, and independently energizing another electrical structure to apply an electrostatic force in the vicinity of a cavity.

Implementations of the invention may include the following features. The one structure is energized to move an element of the cavity to a first position, and the other electrical structure is energized to maintain the element in the first position. The one structure is de-energized while the other structure remains energized. The energizing of the one electrical structure and the other electrical structure is controlled to effect more than two optical states of the cavity. One electrical structure is energized to apply an electrostatic force in the vicinity of each of multiple other cavities, and another electrical structure is independently energized to apply an electrostatic force in the vicinity of each of the multiple other cavities. The energizing of the electrical structures is controlled to independently control the optical states of groups of one or more of the cavities.

Other advantages and features will become apparent from the following description and from the claims.

DESCRIPTION

FIG. 1 is a schematic side view of a MEMS.

FIG. 2 shows a hysteresis curve.

FIG. 3 is a top view of an iMoD array.

FIGS. 4 and 5 are a side view and a top view of an iMoD array.

FIG. 6 shows a hysteresis curve.

FIGS. 7, 9, 10, 11, 13, 14, 15, and 16 are side sectional views of various interference modulator configurations.

FIGS. 17*a*, 17*b*, and 17*c* show hysteresis curves.)

As shown in FIG. 3, in an array **28** of interferometric modulators (iMoDs) **30**, each of the iMoDs can be con-